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Report: SA-TR18-1070

Date: 12 February 1960

Report Title: A Determination of the Distribution of Chromium Plate in the
Bores of Small Arms Barrels.

Author:

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Chief, Res and Dev Div

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Project Title: Engineering for the Application of Chromium Plating of Small Arms Barrel Bores.

Ord Project: Industrial Preparedness Measure

DA Project: None

Preparing Agency: Springfield Armory
Springfield, Mass.

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ABSTRACT

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Springfield Armory, Springfield, Mass.

A DETERMINATION OF THE DISTRIBUTION OF CHROMIUM PLATE
IN THE BORES OF SMALL ARMS BARRELS, M. S. Spivak, Tech
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1. Chromium Plating -
Distribution
2. Plating, Chromium
3. Gun barrels -
Plating

An investigation was made to develop a method for the determination of the distribution of chromium plate in the bores of small arms barrels. Barrels of various calibers were chromium plated according to Springfield Armory procedures. These barrels were then sectioned and the chromium thickness was measured at the lands and grooves. Graphs were plotted of groove chromium thickness versus land chromium thickness for the various barrels. Ratios of land-to-groove chromium plating thicknesses have been established for calibers 0.30, 0.45, 0.50, 20mm, and 30mm barrel bores. These ratios apply to barrel bores which have been chromium plated under existing plating procedures used at Springfield Armory. Procedures are described and results discussed.

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SUBJECT

A determination of the Distribution of Chromium Plate in the Bores of Small Arms Barrels.

OBJECT

To determine the ratio of chromium deposited on the lands to that deposited on the grooves in small arms barrels, thereby providing a means of calculating the chrome thickness on either segment when only one has been measured.

SUMMARY

1. Various caliber barrels were chrome plated according to existing Springfield Armory procedures, and then sectioned to permit measurement of chromium thickness at the lands and grooves. A graph of Groove Chromium Thickness VS Land Chromium Thickness for the various barrels was plotted, thereby permitting the determination of the land-to-groove ratio for each barrel tested.

2. Copper and steel anodes were used in the plating procedures.

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1. INTRODUCTION

- a. Existing methods employed at the Springfield Armory for inspection of barrel bores and gaging of chromium plating thickness depend on measurement of the bore diameter (at the lands) after the lands and grooves have been electropolished, and again, after they have been chrome-plated. One half of the differential in readings is accepted as being representative of the amount of chromium deposited in the bore. Chromium thickness on the grooves is not measured. It has been found, however, that groove information is highly desirable.
- b. It was necessary to develop a method for determining the thickness of chromium deposited in the grooves without involving redesign of gages or modification of the plating procedure.
- c. A possible method is the establishment of a ratio of groove-to-land thickness (providing that variations in plating procedure are taken into account) for each caliber barrel.

2. MATERIALS AND EQUIPMENT

a. Barrels:

Barrels of various sizes ranging from .30 caliber to 30mm on the bore diameter.

b. Plating:

- (1) Generator (12 volt)
- (2) Steel and Copper electrodes between 1/8 inch and 3/8 inch diameter.
- (3) Standard electropolishing and chromium plating solutions. See Tables I and II for compositions.

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2. MATERIALS AND EQUIPMENT - Continued

(4) Air gages, electropolishing and electroplating, for each caliber barrel.

(5) Fixtures

c. Metallographic:

(1) Saw (metal cutting, automatic)

(2) Grinding Machine

(3) Abrasive papers of various grit size.

(4) Wax finishing wheel

(5) Lucite mounting material

(6) Mount compressor

(7) Metal etchant

(8) Microscope

3. PROCEDURE

a. Electropolishing and Plating

All barrels were electropolished, and plated in the standard solutions. (See Tables I and II). The amount of chromium deposited during electro-plating was approximately equal to the amount of steel removed during electropolishing. The barrels were gaged after each procedure. Gaging methods used were those currently practiced at the Springfield Armory.

TABLE I

Composition of Chrome Plating Solution

| * Constituent | Composition | |
|--|-------------|-------|
| | oz/gal | g/l |
| Hexavalent Chromium (Calc. as CrO_3) | 29.0 | 218.0 |
| Trivalent Chromium (Calc. as CrO_3) | 3.4 | 26.0 |
| Sulfate (Calc. as H_2SO_4) | 0.34 | 2.6 |
| Iron | 0.40 | 3.0 |

$$\begin{array}{l} \text{* Chromic Acid} = \frac{104}{\text{Sulphate}} \\ \quad \quad \quad \quad \quad \quad 1 \end{array}$$

TABLE II

* Composition of Electropolishing Solution

| Constituent | Per cent Composition |
|-------------|----------------------|
| Sulphate | 34.10 |
| Phosphate | 37.09 |
| Iron | 1.93 |

$$\text{* Specific Gravity at } 75^\circ\text{F} = 1.67$$

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3. PROCEDURE - Continued

b. Sectioning

Two or more representative sample sections of each plated barrel were submitted for investigation. The section faces were ground perpendicular to the plated surfaces, and submitted to metallographic procedures. All sections were etched with a 5% Nital solution.

c. Determination of Thickness

Thickness of chromium deposit was determined by microscopic measurement using magnifications of 250X and 1,000X. Land and groove thicknesses were measured consecutively around the interior perimeter of the sample sections; the number of lands and grooves varied with bore size (See Table III). The thickness measurements were then averaged (See Table IV), and the mean of each section was taken as representative of the chromium thickness (See Figures 1, 2, and 3).

TABLE III

Number of Lands and Grooves
in Various Barrel Bores

| Barrel | No. of Lands | No. of Grooves |
|-------------|--------------|----------------|
| .30 Caliber | 4 | 4 |
| .45 Caliber | 6 | 6 |
| .50 Caliber | 8 | 8 |
| 20mm | 9 | 9 |
| 30mm | 16 | 16 |

4. DISCUSSION OF RESULTS

- a. The results of Figures 1, 2, and 3 indicate that, in general, the ratio of groove-to-land chromium thickness (less than '1" in all of the barrels

TABLE IV

Average Thicknesses of Chromium Plate in Barrel Bores

| Type Bbl. | Anode Used | Av. Thickness of Chromium on the Land Thickness (10^{-3} inches) | Av. Thickness of Chromium on the Groove Thickness (10^{-3} inches) |
|-----------|------------|--|--|
| .30 Cal. | Steel | 3.80 | 3.13 |
| | | 3.05 | 2.64 |
| | | 2.43 | 2.07 |
| | | 3.52 | 2.80 |
| | | 5.21 | 4.71 |
| | | 5.75 | 4.72 |
| | | 9.48 | 8.44 |
| | | 9.74 | 8.62 |
| .30 Cal. | Copper | 1.70 | 1.19 |
| | | 2.08 | 1.45 |
| | | 5.37 | 4.39 |
| | | 5.75 | 5.09 |
| | | 11.30 | 9.87 |
| | | 11.42 | 9.91 |
| .45 Cal. | Steel | 1.32 | 1.06 |
| | | 1.42 | 1.11 |
| | | 1.57 | 1.26 |
| | | 1.57 | 1.28 |
| | | 5.28 | 4.84 |
| | | 1.04 | 1.00 |
| | | 5.69 | 4.95 |
| | | 6.44 | 5.88 |
| | | 6.53 | 5.86 |
| | | 1.03 | .97 |
| | | 1.82 | 1.63 |

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TABLE IV - Continued

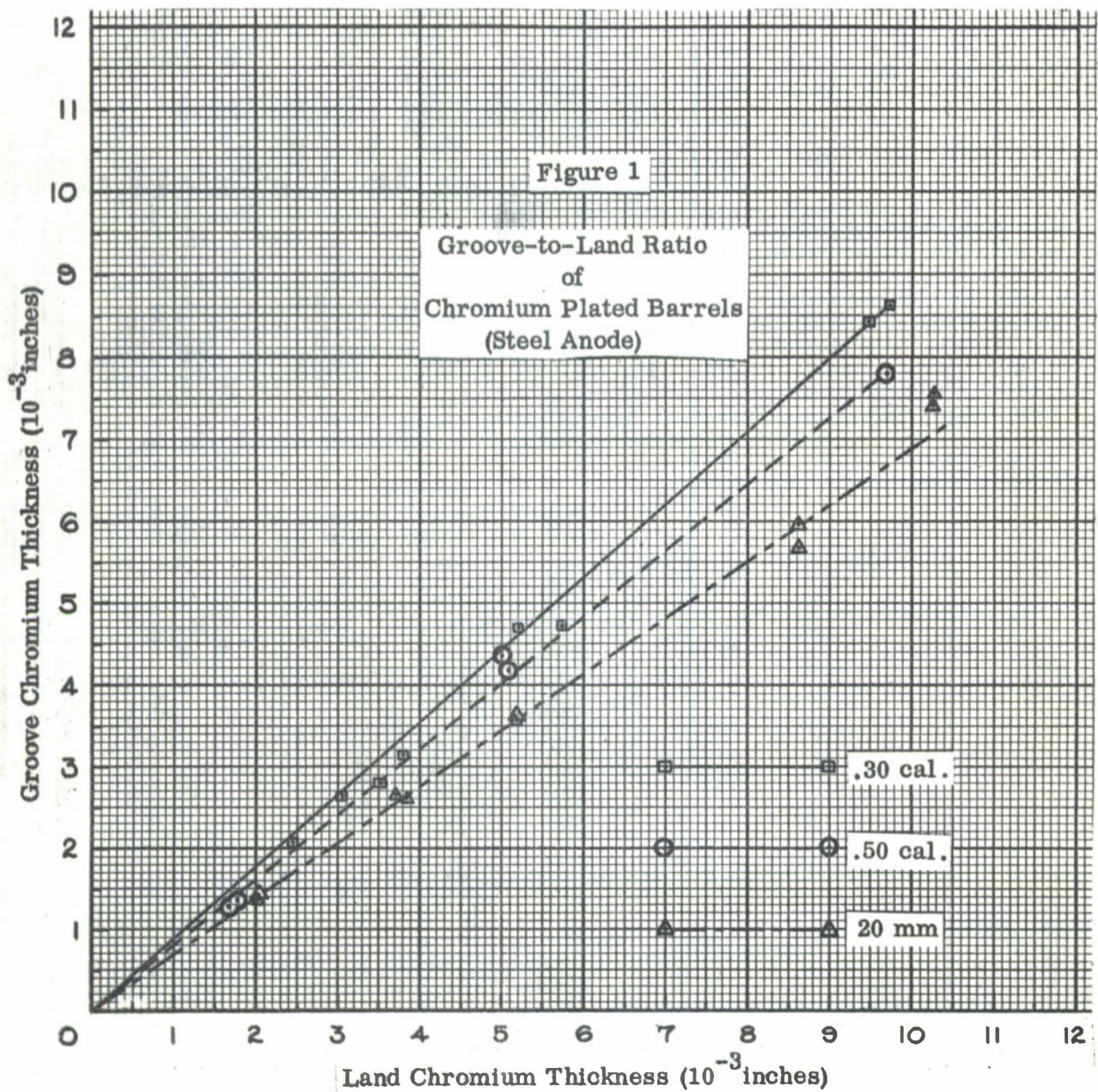
Average Thicknesses of Chromium Plate in Barrel Bores

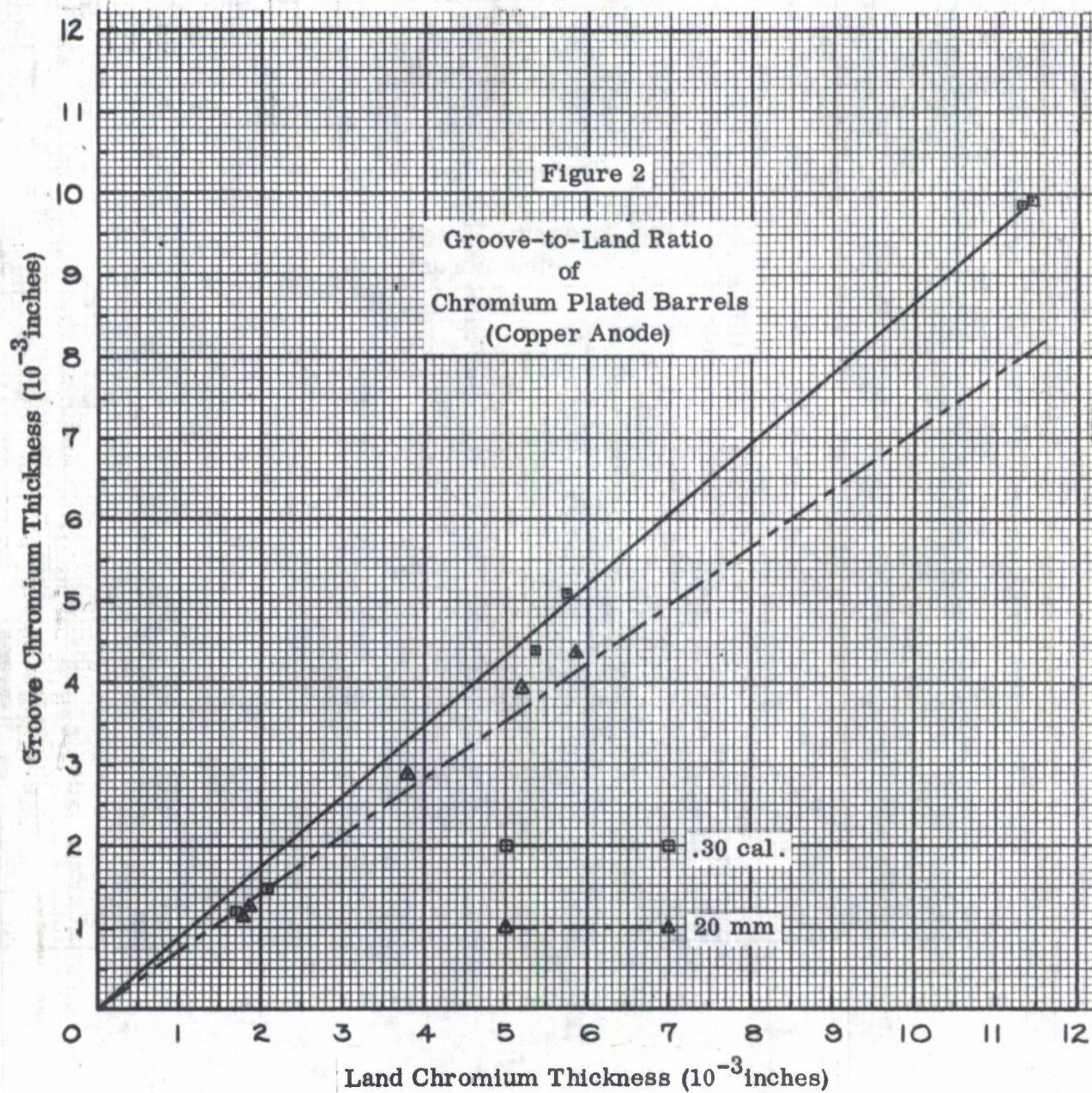
| Type Bbl. | Anode Used | Av. Thickness of Chromium on the Land Thickness (10^{-3} inches) | Av. Thickness of Chromium on the Groove Thickness (10^{-3} inches) |
|-----------|------------|--|--|
| .45 Cal. | Steel | 6.80 | 5.97 |
| | | 7.25 | 6.61 |
| | | 8.55 | 7.58 |
| .50 Cal. | Steel | 1.66 | 1.28 |
| | | 1.78 | 1.37 |
| | | 5.00 | 4.35 |
| | | 5.08 | 4.17 |
| | | 9.70 | 7.80 |
| 20mm | Steel | 2.01 | 1.38 |
| | | 2.02 | 1.43 |
| | | 3.71 | 2.65 |
| | | 3.83 | 2.61 |
| | | 5.17 | 3.61 |
| | | 5.18 | 3.58 |
| | | 8.62 | 5.68 |
| | | 8.62 | 5.96 |
| | | 10.25 | 7.41 |
| 20mm | Copper | 10.25 | 7.55 |
| | | 1.78 | 1.14 |
| | | 1.87 | 1.26 |
| | | 3.80 | 2.88 |
| | | 5.20 | 3.95 |
| | | 5.87 | 4.35 |

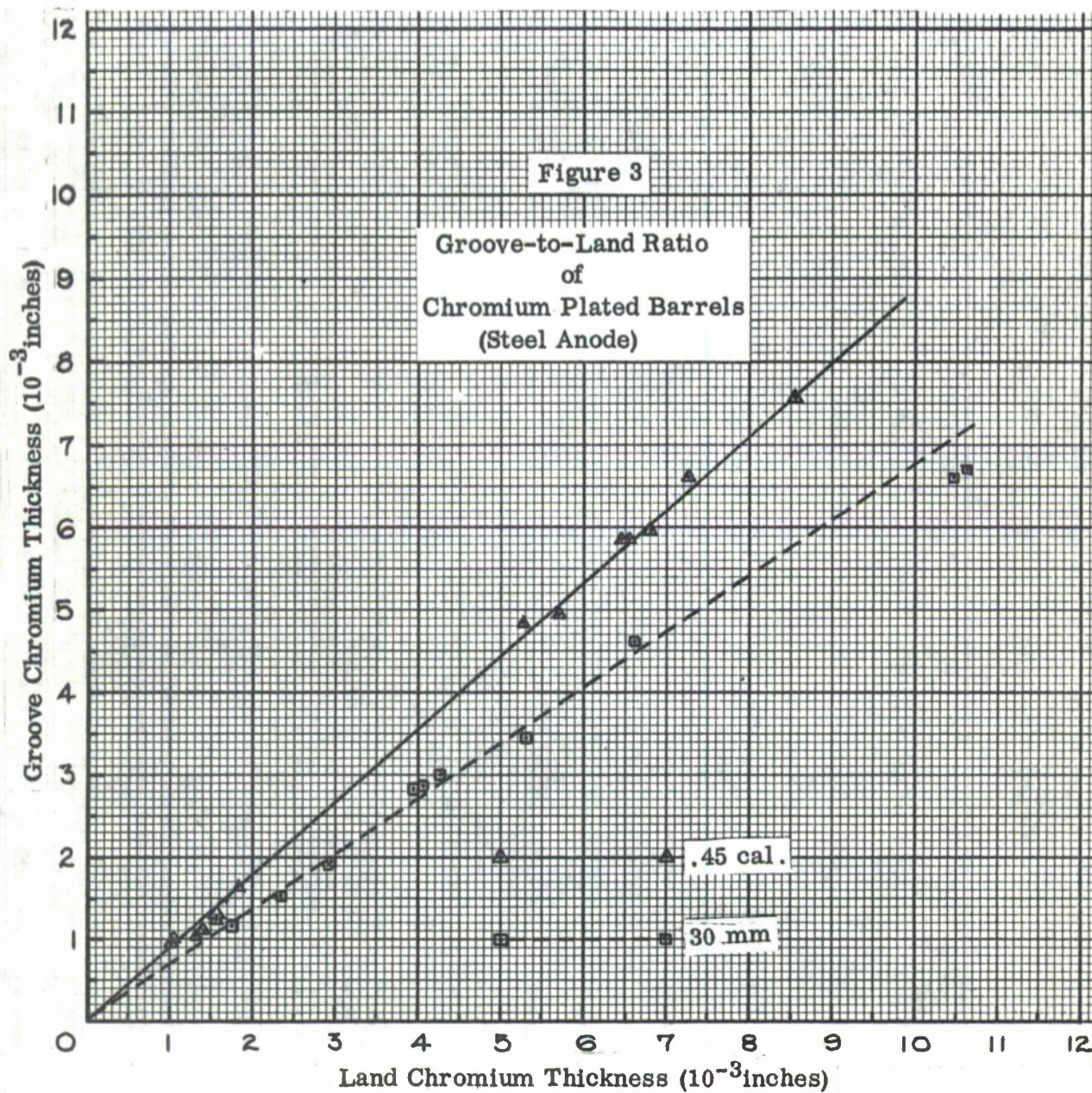
TABLE IV - Continued

Average Thickness of Chromium Plate in Barrel Bores

| Type Bbl. | Anode Used | Av. Thickness of Chromium on the Land Thickness (10^{-3} inches) | Av. Thickness of Chromium on the Groove Thickness (10^{-3} inches) |
|-----------|------------|--|--|
| 30mm | Steel | 1.75 | 1.15 |
| | | 3.93 | 2.82 |
| | | 4.04 | 2.87 |
| | | 4.25 | 3.00 |
| | | 6.60 | 4.60 |
| | | 2.31 | 7.43 |
| | | 2.34 | 1.53 |
| | | 2.92 | 1.92 |
| | | 2.93 | 1.94 |
| | | 5.30 | 3.44 |
| | | 10.47 | 6.60 |
| | | 10.62 | 6.70 |







4. DISCUSSION OF RESULTS - Continued

examined) decreases as the barrel size increases. The exception to this pattern appears in the case of the .45 caliber barrels, where the curve approximates that of the .30 caliber barrel.

- b. Anode material (copper or steel) appears to have little effect on the groove-to-land chromium thickness ratio.

5. CONCLUSIONS

The ratio of land-to-groove chromium plating thickness has been established (See Figures 1, 2, and 3) for .30 caliber, .45 caliber, .50 caliber, 20mm, and 30mm barrel bores. The ratios apply to barrel bores which have been chromium plated under existing plating procedures used at the Springfield Armory.

6. RECOMMENDATIONS

A study should be made to determine the change of inside diameter of the bores (measured at the grooves) resulting from the difference of steel removal during electropolishing and chromium deposited during plating.

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